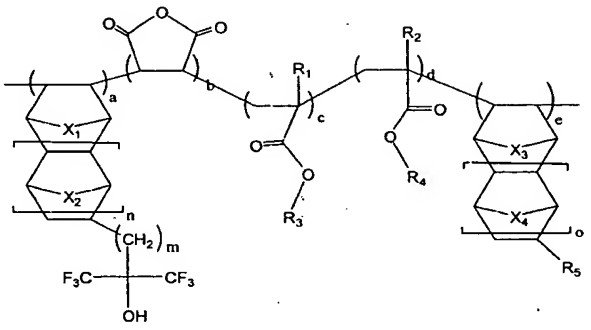
What is Claimed is:

1. A photoresist polymer comprising a repeating unit represented by Formula 1:

Formula 1



wherein

X_1, X_2, X_3 and X_4 individually are selected from the group consisting of CH_2, CH_2CH_2, O and S;

R_1 and R_2 individually are selected from the group consisting of H, CH_3 and CF_3;

R_3 is selected from the group consisting of an acid labile protecting group, C_1-C_{20} alkyl and C_1-C_{20} cycloalkyl;

R_4 is selected from the group consisting of C_1-C_{20} hydroxyalkyl, C_1-C_{20} hydroxyalkyl having halogen substituent, C_5-C_{10} alkyl including an ether group, C_5-C_{10} alkyl including an ester group, C_5-C_{10} cycloalkyl including an ether group, and a C_5-C_{10} cycloalkyl including an ester group;

R_5 is selected from the group consisting of H, C_1-C_{20} alkyl, C_1-C_{20} alkyl carboxylate, and –O-R_7, wherein R_7 is C_1-C_{20} cycloalkyl;

m is an integer ranging from 0 to 2;

n is an integer of 0 or 1; and

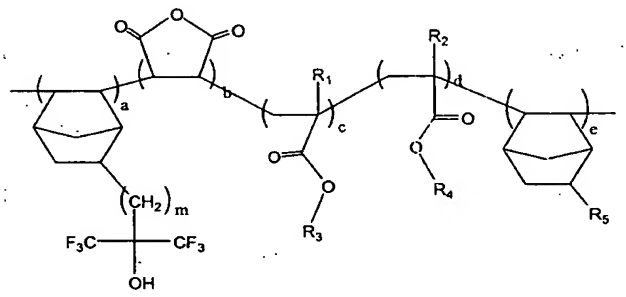
the relative ratio of a : b : c : d : e is in the range of 1~20 mol% :

1~20 mol% : 10~60 mol% : 1~40 mol% : 0~30 mol%.

2. The photoresist polymer according to claim 1, wherein the acid labile protecting group is selected from the group consisting of t-butyl, tetrahydropyran-2-yl, 2-methyl tetrahydropyran-2-yl, tetrahydrofuran-2-yl, 2-methyl tetrahydrofuran-2-yl, 1-methoxypropyl, 1-methoxy-1-methyl ethyl, 1-ethoxypropyl, 1-ethoxy-1-methyl ethyl, 1-methoxyethyl, 1-ethoxyethyl, t-butoxyethyl, and 1-isobutoxyethyl and 2-acetylment-1-yl.

3. The photoresist polymer according to claim 1, wherein the polymer comprises repeating unit of Formula 1a:

Formula 1a



wherein

X_1, X_2, X_3 and X_4 individually are selected from the group consisting of CH_2, CH_2CH_2, O and S;

R_1 and R_2 individually are selected from the group consisting of H, CH_3 and CF_3;

R_3 is selected from the group consisting of an acid labile protecting group, C_1-C_{20} alkyl and C_1-C_{20} cycloalkyl;

R_4 is selected from the group consisting of C_1-C_{20} hydroxyalkyl, C_1-C_{20} hydroxyalkyl having halogen substituent, C_5-C_{10} alkyl including an ether group, C_5-

C_{10} alkyl including an ester group, C_5-C_{10} cycloalkyl including an ether group, and C_5-C_{10} cycloalkyl including an ester group;

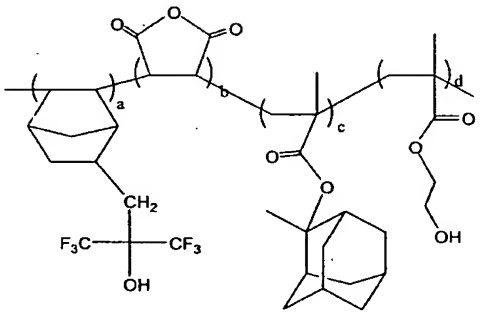
R_5 is selected from the group consisting of H, C_1-C_{20} alkyl, C_1-C_{20} alkyl carboxylate and –O-R_7, wherein R_7 is C_1-C_{20} cycloalkyl;

m is an integer ranging from 0 to 2; and

the relative ratio of a : b : c : d : e is in the range of 1~20 mol% : 1~20 mol% : 10~60 mol% : 1~40 mol% : 0~30 mol%.

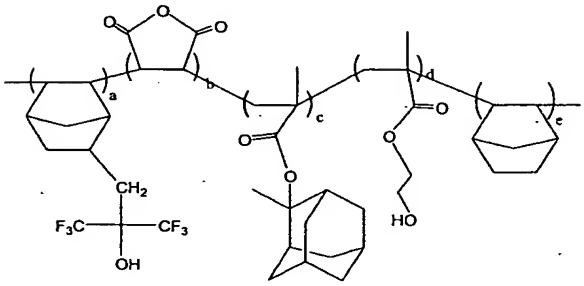
4. The photoresist polymer according to claim 3, wherein the polymer having repeating unit of Formula 1a is selected from the group consisting of Formulas 1b to 1h:

Formula 1b



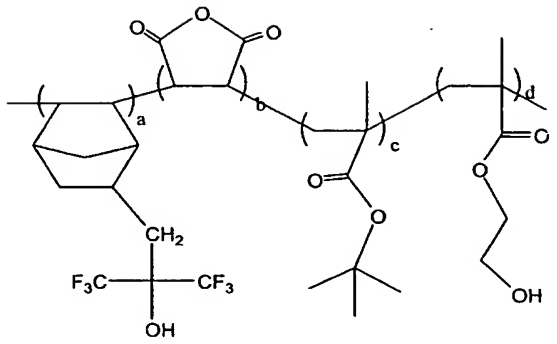
;

Formula 1c



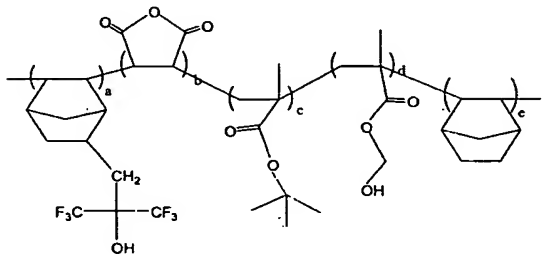
;

Formula 1d



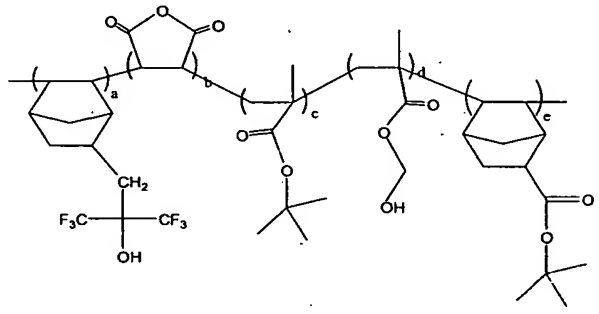
;

Formula 1e



;

Formula 1f



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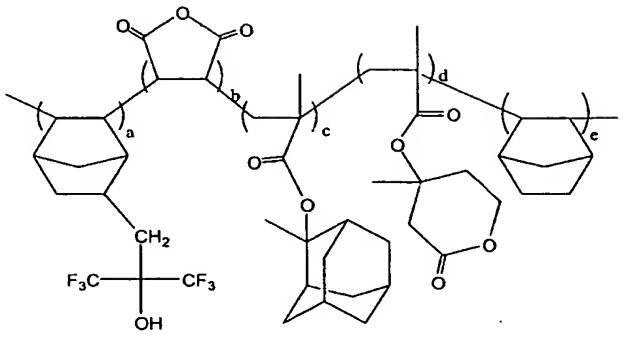
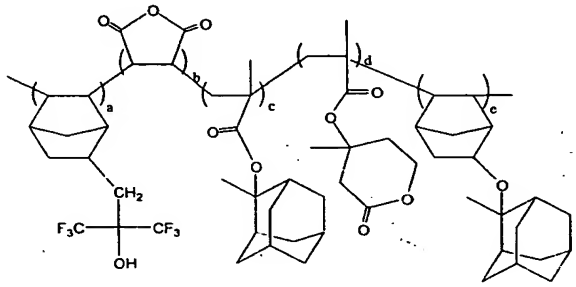
Formula 1g



; and

Formula 1h



,

wherein

the relative ratio of a : b : c : d is in the range of 1~20 mol% : 1~20 mol% : 10~60 mol% : 1~40 mol% ; and

the relative ratio of a : b : c : d : e is in the range of 1~20 mol% : 1~20 mol% : 10~60 mol% : 1~40 mol% : 0~30 mol%.

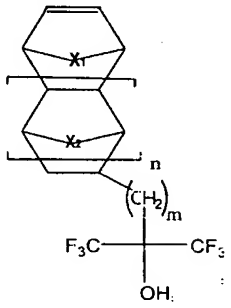
5. A method for forming a photoresist polymer, comprising the step of:

(a) dissolving maleic anhydride, a compound of Formula 2, a compound of Formula 3, a compound of Formula 4 and optionally a compound of Formula 5 in a polymerization solvent;

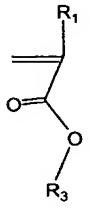
(b) adding a polymerization initiator in the resulting solution of step (a); and

(c) reacting the resulting solution of step (b) under a nitrogen or argon atmosphere to obtain a polymer having repeating unit of following Formula 1 at a temperature ranging from 60 to 70 °C for 4 to 24 hours.

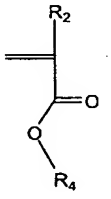
Formula 2



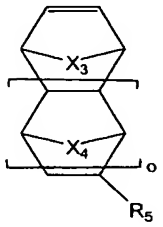
Formula 3



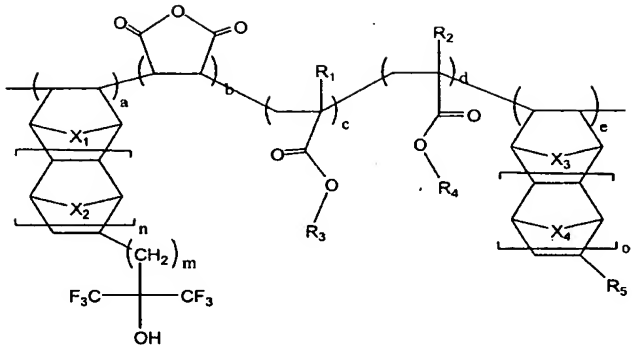
Formula 4



Formula 5



Formula 1



wherein

X_1, X_2, X_3 and X_4 individually are selected from the group consisting of CH_2, CH_2CH_2, O and S;

R_1 and R_2 individually are selected from the group consisting of H, CH_3 and CF_3;

R_3 is selected from the group consisting of an acid labile protecting group, C_1-C_{20} alkyl and C_1-C_{20} cycloalkyl;

R_4 is C_1-C_{20} hydroxyalkyl, C_1-C_{20} hydroxyalkyl having halogen substituent, C_5-C_{10} alkyl including an ether, C_5-C_{10} alkyl including an ester group, C_5-C_{10} cycloalkyl including an ether and C_5-C_{10} cycloalkyl including an ester group;

R_5 is selected from the group consisting of H, C_1-C_{20} alkyl, C_1-C_{20} alkyl carboxylate and –O-R_7, wherein R_7 is C_1-C_{20} cycloalkyl;

m is an integer ranging from 0 to 2;

n is an integer of 0 or 1; and

the relative ratio of a : b : c : d : e in the range of 1~20 mol% : 1~20 mol% ; 10~60 mol% : 1~40 mol% : 0~30 mol%.

6. The method according to claim 5, wherein the polymerization solvent of step (a) is selected from the group consisting of cyclohexanone, cyclopentanone, tetrahydrofuran, dimethylformamide, dimethylsulfoxide, dioxane, methylethylketone, benzene, toluene, xylene and mixtures thereof.

7. The method according to claim 5, wherein the polymerization initiator of step (b) is selected from the group consisting of benzoylperoxide, 2,2'-azobisiso-butyronitrile (AIBN), acetylperoxide, laurylperoxide, t-butylperacetate, t-butylhydroperoxide and di-t-butylperoxide.

8. The method according to claim 5, wherein the polymer obtained from step (c) is crystallized and purified using single or mixture solution selected from the group consisting of dimethylether, petroleum ether, methanol, ethanol, lower alcohol including iso-propanol, and water.

9. A photoresist composition comprising a photoresist polymer of claim 1, a photoacid generator and an organic solvent.

10. The photoresist composition according to claim 9, wherein the photoacid generator is selected from the group consisting of phthalimidotrifluoromethane sulfonate, dinitrobenzyltosylate, n-decyl disulfone and naphthylimido trifluoromethane sulfonate.

11. The photoresist composition according to claim 9, wherein the photoacid generator comprises

(i) a first photoacid generator is selected from the group consisting of phthalimidotrifluoromethane sulfonate, dinitrobenzyltosylate, n-decyl disulfone and naphthylimido trifluoromethane sulfonate; and

(ii) a second photoacid generator is selected from the group consisting of diphenyl iodide hexafluorophosphate, diphenyl iodide hexafluoroarsenate, diphenyl iodide hexafluoroantimonate, diphenyl p-methoxyphenylsulfonium triflate, diphenyl p-toluenylsulfonium triflate, diphenyl p-isobutylphenylsulfonium triflate, triphenylsulfonium hexafluororarsenate, triphenylsulfonium hexafluoro-antimonate, triphenylsulfonium triflate, and dibutyl-naphthylsulfonium triflate.

12. The photoresist composition according to claim 9, wherein the photoacid generator is present in an amount ranging from 0.05 to 10 wt% to the photoresist polymer.

13. The photoresist composition according to claim 9, wherein the organic solvent is selected from the group consisting of diethylene glycol diethyl ether, methyl 3-methoxypropionate, ethyl 3-ethoxypropionate, propylene glycol methyl ether acetate, cyclohexanone, 2-heptanone, and ethyl lactate.

14. The photoresist composition according to claim 9, wherein the organic solvent is present in an amount ranging from 500 to 2000 wt% to the photoresist polymer.

15. A method for forming a photoresist pattern, comprising the step of:

(a) coating the photoresist composition of claim 9 on a wafer to form a photoresist film;

(b) exposing the photoresist film to light;

(c) baking the exposed photoresist film; and

(d) developing the photoresist film to obtain a photoresist pattern.

16. The method according to claim 15, further comprising performing a bake process before exposure of step (b).

17. The method according to claim 15, wherein the bake process is performed at a temperature ranging from 70 to 200 °C.

18. The method according to claim 15, wherein the light is selected from the group consisting of KrF, ArF, EUV (Extreme Ultra Violet), VUV (Vacuum Ultra Violet), E-beam, X-ray and ion beam.

19. The method according to claim 15, wherein the exposure process is performed with exposure energy ranging from 0.1 to 100 mJ/cm^2.

20. The method according to claim 15, wherein the development of step (d) is performed using an alkaline developing solution.